Electronics & Communication Engineering			
ECC701	**Optical Fiber Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Identify and Develop the basic knowledge of different components of an Optical Fiber Communication theory.
CO2	Analyze the problems related to optical source, Fiber and Detector operational parameters.
CO3	Design and Investigate thecomplex problems related to high speed links, MUX, DEMUX, and different optical fiber link design parameters.
CO4	Use Modern Tool to analyze the concepts of WDM, Optical Amplifiers, Optical Switching and networking technology.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	-	-	-	-	-	-	-	-	2
CO2	1	3	-	-	1	-	-	-	-	-	-	1
CO3	1	-	3	2	-	-	-	-	-	-	-	1
CO4	-	-	1	1	3	-	-	-	-	-	-	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to optical fiber communication**: Principles and systems, Different types of fibers, SMF & MMF, Ray Theory analysis for step index fiber only. Fiber optic transmitters using LEDs and Laser diodes, Bias stabilization of LEDs and Lasers, Driver circuits for analog and digital modulation, Temperature stabilization of laser diodes, Modulation bandwidths of lasers and LEDs.	**8**
2	Fiber optic receivers using PIN and APD photodiodes, photo-diode amplifiers, SNR in PID and APD receivers, Receiver sensitivity, Eye diagram.	**8**
3	Coupling mechanisms of optical power from source to fiber and fiber to photo detector, Transmission characteristics of fibers and their effects on system performance, Selection of optical fiber types for short-haul, long-haul and high speed data links, optical power budget calculations of a fiber optic communication link.	**8**

4	Fiber optic interconnectivity devices for fiber optic communication links and networks: Optical isolators, polarizer, circulators, attenuators, Bragg grating filters, add/drop multiplexers, WDM MUX / DEMUX, fiber amplifiers, guided wave devices as external optical modulators.	**8**
5	Fiber optic analog modulation methods, Sub-carrier multiplexed analog communication principles, IM-DD systems, Fundamentals of optical coherent detection, Optical pulse format for digital communication systems, Performance of a 10 Mb/s digital fiber optic link and a 10 Gb/s data link, Effects of charp and line widths of lasers on system performance, Fiber optic networks for LAN, MAN and WAN – a brief study.	**8**

Text Books:

1. Optical fiber communications: principles and practice. Front Cover. John M. Senior.
2. “Cabling: The Complete Guide to Copper and Fiber-Optic Networking” by Andrew Oliviero and Bill Woodward.
3. “Fiber-Optic Transmission Networks: Efficient Design and Dynamic Operation (Signals and Communication Technology)” by Stephan Pachnicke.
4. “Fiber Optics Illustrated Dictionary (Advanced & Emerging Communications Technologies)” by J K Petersen.

Electronics & Communication Engineering			
ECP702	**Mobile Communication**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand WLANs and their architecture
CO2	Design WAP pages using Wireless MarkUp language
CO3	Classify and distinguish different mobile communication generations and their architecture
CO4	To gain knowledge of different mobile transport layers

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	-	-	-	-	-	-	-
CO2	2	-	-	2	3	-	-	-	-	-	-	-
CO3	2	-	-	3	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**An Overview of Wireless Systems:** Introduction, Mobility versus portability, Mobile devices, Wireless communication and the layer model, First and Second Generation Cellular Systems, Cellular Communications from 1G to 3G Road Map for Higher Data Rate Capability in 3G, Wireless 4G Systems, Future Wireless Networks, Standardization Activities for Cellular Systems.	**8**
2	**Cellular System design concepts and fundamentals:** Frequency Reuse, Channel Assignment, Handoff Strategies, Interference and System Capacity, Trunking and Grade of service, Improving Coverage and Capacity in cellular systems. Mobile Radio Wave propagation, Large scale path loss and propagation models, Reflection, Diffraction, Scattering, Practical link budget design, Outdoor propagation models, Indoor propagation models	**8**
3	**Mobile Radio Wave propagation:** Small-Scale fading and multipath propagation, Rayleigh and Ricean Distributions, Multiple	**8**

	Access Techniques for Wireless Communications, FDMA, TDMA, Spread Spectrum multiple access, FHMA, CDMA, SDMA.	
4	**Multiple Access Techniques for Wireless Communications:** Packet radio, Pure ALOHA, Slotted ALOHA, CSMA, Reservation ALOHA, PRMA, Capacity of Cellular Systems, Wireless systems and standards, AMPS and ETACS, IS 54 and IS 136 GSM features, Architecture, Radio subsystems, Traffic channels, call processing.	**8**
5	**Wireless systems and standards:** CDMA features, Architecture, IS-95 Forward and reverse channels, power control, system capacity. Wireless Networking, WLAN, PAN, Mobile network layer, Mobile Transport layer, Wireless data services, Common channel signaling; Introduction to OFDM . **Wireless Networking:** Satellite data communication, cellular data communications, third generation UMTS system features, Wi MAX, RFID	**10**

Text Books:

1. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks", Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N. Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications.
5. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.

Electronics & Communication Engineering			
ECP703	**Satellite Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the orbital and functional principles of satellite communication systems
CO2	Architect, interpret, and select appropriate technologies for implementation of specified satellite communication systems.
CO3	Analyze and evaluate a satellite link and suggest enhancements to improve the link Performance.
CO4	Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.
CO5	Specify, design, prototype and test analog and digital satellite communication systems as per given specifications.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	2	1	2	1	-	-	-	2	2
CO2	1	-	-	1	2	2	2	-	-	-	2	2
CO3	-	-	-	-	2	2	1	-	-	-	2	2
CO4	1	-	-	-	3	2	1	-	-	-	2	2
CO5	1	1	-	-	3	2	1	-	-	-	2	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction:** Overview of Satellite Communications, GEO, MEO and LEO satellite systems, frequency bands Orbital Mechanics: Orbit Equations, Locating the satellite w.r.t. the earth, Orbital elements, look Angles, Orbital perturbation, Effects of earth's oblate ness ,moon and sun , Satellite eclipse, sun transit outage, Coverage angle, slant range, satellite launching.	10
2	**Satellite subsystems:** Attitude and Orbit Control System (AOCS), Telemetry, Tracking and Command System (TT&C), Power System, Satellite antennas, Communications subsystem, transponders.	8

3	**Satellite Link Design:** Basic transmission theory, System noise temperature and G/T ratio, CNR, CIR, ACI, IMI, down link design, up link design, System design examples.	**6**
4	**Modulation and Multiplexing:** FM with multiplexed telephone signals, Analog FM SCPC, PSK, QPSK, Multiple Access Schemes: FDM/FM/FDMA, TDMA, Frame structure, frame acquisition, synchronization, TDMA in VSAT network, On-board processing, CDMA, Spread spectrum transmission and reception, DS-SS CDMA capacity.	**8**
5	**Error Control for Digital Satellite Links:** Error control coding, Block codes, Convolution codes, Implementation of error detection on satellite links. **VSAT Systems:** Overview of VSAT systems, Network architectures, Access control, multiple access selection. **LEO Satellite systems:** Orbits, Coverage and frequency bands, off axis scanning, delay and throughput, NGSO constellation design, Problems.	**8**

Text Books:

1. Timothy Pratt, Charles Bostian Jermey Allnutt, Satellite Communications, John Wiley, Singapore, Second Edition, reprint 2013.
2. M. Richharaia, Satellite Communication Systems, BS Publishers, Second Edition, 2008.
3. TRI.T. HA, Digital Satellite Communications, McGraw-Hill, 2000.

Electronics & Communication Engineering			
ECP704	**Nanotechnology and Application**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	**Understand the properties of Nano-materials and applications.**
CO2	**Apply chemical engineering principles to Nano-particle production.**
CO3	**Solve the quantum confinement equations.**
CO4	**Characterize Nano-materials.**
CO5	**Scale up the production Nanoparticles for Electronics and Chemical industries.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	-	-	-	2	-	-	3
CO3	3	-	-	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	2	-	-	3
CO5	-	-	-	-	-	-	-	-	-	-	2	3

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to Nanotechnology:** Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano-sizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.	**5**
2	**Fabrication of Nanomaterials:** Top Down Approach Grinding, Planetory milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions. Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance,	**10**

	Layers of surface charges, Zeta Potential and pH.	
3	**Carbon Nanomaterials:** Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C60, bucky onions, nanotubes, nanocones. **Quantum mechanics:** Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots.	**7**
4	**Nanomaterials characterization:** Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application, Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy. **Applications:** Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials, Nano inroganic materials of CaCO3 synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices.	**10**
5	**Nanobiology:** Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts.	**6**

Text books:

1) Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2) Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3) Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4) Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press.
5) Davies, J.H. ‘The Physics of Low Dimensional Semiconductors: An Introduction’, Cambridge University Press, 1998.

Electronics & Communication Engineering			
ECP705	**Antenna & Wave Propagation**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the concept of radiation through mathematical formulation
CO2	Plot the characteristics of wire and aperture antennas
CO3	Develop the performance characteristics of array antennas
CO4	Measure the antenna parameters
CO5	Apply the concept of antenna in mobile communication

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	2	-	-	-	-	-	-	-	-	-
CO3	-	2	-	2	-	-	-	-	-	-	-	-
CO4	-	-	3	3	2	-	-	-	-	-	-	-
CO5	3	2	-	2	3	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course Content	No. of Lecture
1	**Antenna Fundamentals:** Introduction to antennas & its significance, Scalar electric potential, vector magnetic potential, radiation from an alternating current element, Induction field, radiation field, power radiated by a current element, Definition of electric dipole, radiation by a half wave dipole. Power by a half wave dipole & its radiation resistance, Radiation from a quarter wave monopole Power radiation and radiation resistance of dipole & monopole, Radiation resistance of aerials and loop, problems Isotropic radiator, network theorem, application of network theorem to antennas.	8
2	**Antenna Parameters:** Radiation pattern, power pattern, field pattern Radiation intensity, Antenna impedance, mutual impedance, gain and directivity, bandwidth, Polarization, efficiency, effective length, area or aperture, scattering loss, Collecting aperture, physical aperture, relation between large aperture and gain Effective aperture of a small elementary dipole, half wave antenna, effective length, front to back ratio, Antenna beam	9

	width and side lobes. Friss Transmission formula, Radar range equation**.**	
3	**Design of Arrays:** N-element linear array- broadside array, End fire array, multiplication of patterns Effect of earth on vertical pattern mutual impedance effects, Binomial arrays, problem solving.	**6**
4	**Practical antennas:** VLF, LF, MF transmitting antennas, resonant & non resonant antennas, V antenna, travelling wave antenna, Rhombic antenna, VHF &UHF antennas, horn antenna Folded dipole & Yagi-Uda antenna, Parabolic reflector antenna,, Corner reflector, Parabolic reflector antenna, Micro strip Antennas**.**	**8**
5	**Antenna impedance measurements:** Radiation pattern measurements Measurement of antenna beam width and gain, Polarization measurements. Measurement of radiation resistance. **Wave Propagation:** Types of wave propagation, space wave propagation and line of sight distance for flat and curved surfaces.	**10**

Text Books:

1. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2007.
2. Antenna Theory: Analysis and Design, Constantine A. Balanis, John Wiley & Sons, 3rd Ed., 2009.
3. David K. Cheng, “Field and Wave Electromagnetics”, Pearson, 2e, 2014.
4. John D. Kraus, Antennas, 2nd Edition, McGraw Hill, 1988.
5. R.E. Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985.
6. David M. Pozar, “Microwave Engineering”, Wiley, 4e, 2012.
7. Ahmed El Zooghby, ‘Smart Antenna Engineering’, ARTECH HOUSE, INC, 2005.
8. Frank B. Gross, ‘Smart antenna with MATLAB’, Second Edition, McGraw-Hill, 2015.

Electronics & Communication Engineering			
ECP706	**RF IC Design**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Ability to design a system, component, or process, and synthesise solutions to achieve desired needs.
CO2	Perform calculation related to modulation and detection
CO3	Design of Critical Components in CMOS RF-IC Design.
CO4	Design of CMOS Low-Noise Amplifier and Mixer
CO5	Perform small signal conversion gain simulation

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	3	2	3	-	-	-	-	-	-	-	-
CO4	1	2	2	2	-	-	-	-	-	-	-	-
CO5	-	1	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to RF and Wireless Technology:** Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology. **Basic Concepts in RF design:** Nonlinearity and time variance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.	**10**
2	**Multiple Access:** Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards.	**8**
3	**Transceiver Architectures:** General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.	**7**
4	**Amplifiers, Mixers and Oscillators:** LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.	**7**

5	**Power Amplifiers:** General considerations, linear and nonlinear Pas, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques.	**8**

Text Books:

1. Razavi Behzad, RF Microelectronics, Prentice-Hall, 1998
2. Couch L W, Digital and Analog Communication Systems, Pearson/Prentice-Hall, c2007.
3. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, 2001.
4. Leung Bosco, VLSI for Wireless Communication, Prentice Hall, 2002

Electronics & Communication Engineering			
ECP707	**Real Time Embedded System**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Illustrate different types of embedded system and present its mathematical model under time Constraint.
CO2	Design methodologies for real time system and its application.
CO3	To understand RTOS and distinguishes between GPOS and RTOS.
CO4	To work on real time language.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	3	2	-	-	-	-	-	-	-
CO2	1		3	2	-	-	-	-	-	-	-	-
CO3	2	1	-	3	-	-	-	-	-	-	-	-
CO4	-	-	2	2	3	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	Introduction-defining Real time systems, Embedded Real Time Systems, Special Characteristics of real time systems, a brief evolutionary history. Hardware Architectures of Real Time systems	**12**
2	Software architectures (concepts of interrupt driven activation, need for real time monitor, pseudo parallelism), meeting of dead-lines & real time constraints.	**5**
3	Overview of WARD & MELLOR Methodology: Ward & Mellor Life Cycle, the essential model step, the implementation model, real time extensions of DFD.	**10**
4	Real time languages: overview of ADA/Java Extension	**4**
5	Real time Operating Systems, System Development Methodologies.	**6**

Text Books:

1. Introduction to Embedded Systems -Shibu K.V, McGraw Hill

2. Embedded Systems Design –Santanu Chattopadhyay, PHI, 2013.
3. Embedded System Design -Frank Vahid, Tony Givargis, John Wiley.
4. Embedded/Real-Time Systems: Concepts Design and Programming, K.V.K.K. Prasad Dreamtech, 2005.
5. Embedded Systems –Lyla, Pearson, 2013.
6. An Embedded Software Primer -David E. Simon, Pearson Education.

Electronics and Communication Engineering			
ECO708	**Soft Computing Technique**	**L**	**T**
		3	**0**

Course Outcomes:

CO1	Understand the concepts of population based optimization techniques
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution
CO3	Evaluate the importance of parameters in heuristic optimization techniques
CO4	Apply for the solution of multi-objective optimization

Mapping of course outcomes with program outcomes:

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	1	1	1	2	1	1	2
CO2	3	3	2	2	3	1	1	1	3	1	1	3
CO3	3	3	2	2	3	1	1	1	3	1	3	3
CO4	3	3	2	2	3	1	1	1	3	1	3	3

Detailed Syllabus:

Module 1. FUNDAMENTALS OF SOFT COMPUTING TECHNIQUES L-12
Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques- Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems -Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

Module 2. GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION L-10
Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.

Module 3. ANT COLONY OPTIMIZATION AND ARTIFICIAL BEE COLONY ALGORITHMS L-10
Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO modelsTouring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Module 4. SHUFFLED FROG-LEAPING ALGORITHM AND BAT OPTIMIZATION ALGORITHM L-10

Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogscomparison of memes and genes -memeplex formation- memeplex updation. Application to multi-modal function optimization Introduction to Multi- Objective optimization- Concept of Pareto optimality.

Reading:

1. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb "Multi-Objective Optimization using Evolutionary Algorithms", John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, "Swarm Intelligence", The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, "Swarm Intelligence-From natural to Artificial Systems", Oxford university Press, 1999.
5. David Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, "Particle Swarm Optimization and Intelligence: Advances and Applications", InformatIon science reference, IGI Global, 2010.
7. N P Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

Electronics & Communication Engineering			
ECO709	**VLSI Design***	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	APPLY the knowledge of semiconductor to review MOSFET characteristics, small geometry effects and scaling.
CO2	DEVELOP voltage, current sources and amplifiers and Operational amplifier made by CMOS.
CO3	CONSTRUCT switched capacitor filters, ADC, DAC and interconnects
CO4	ANALYZE CMOS Inverter, Dynamic CMOS, Pass transistor and transmission gates
CO5	DESIGN CMOS combinational, sequential circuits and memories

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	1	-	-	-	-	-	-	1
CO2	3	3	3	3	3	-	-	-	-	-	-	1
CO3	3	3	3	3	3	-	-	-	-	-	-	1
CO4	3	3	3	3	3	-	-	-	-	-	-	1
CO5	3	3	3	3	3	-	-	-	-	-	-	1

DETAILED SYLLABUS

Module	Content	No. of Lectures
1	**Introduction:** Review of MOSFET characteristics, scaling and small-geometry effects, and MOSFET capacitances. MOS resistor, MOS current source, current mirror circuits. MOS voltage source, linear voltage and current converters.	**6**

2	**CMOS operational amplifier (OPAMP) design:** Differential amplifier, level shifter, source follower, output stage voltage and power amplifiers. Cascode OP-AMP. Compensation techniques. **Analog Filters:** Switched capacitor (SC) fundamentals, first order SC circuits, second-order SC circuits and cascade design. Analog to digital and digital to analog converters, speed of conversion and over sampling issues. **VLSI Interconnects:** Distributed RC model, transmission line model. Future inter connect technologies.	**14**
3	**Digital VLSI Circuit Design:** MOS inverters, CMOS inverter, state characteristics, switching characteristics, power dissipation issues. **CMOS logic gates:** NAND, NOR, XOR, CMOS logic design of half and full adders. CMOS transmission gates, pseudo-nMOS, domino logic gates.	**9**
4	**Sequential MOS Logic Circuits:** The SR latch circuit, clocked latch and flip-flop, CMOS D-latch and edge-triggered circuits, Schmitt trigger circuit, Comparator. **Dynamic Logic Circuits:** Pass transistor logic, synchronous dynamic circuit techniques.	**8**
5	**Semiconductor Memories:** ROM circuits, SRAM circuits, DRAM circuits, drivers and buffers, Buffer scaling and design issues	**5**

Text Books:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective,
   4th Edition, Pearson Education, 2015.

Electronics & Communication Engineering			
ECO710	**5G Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Learn 5G technology & its features.
CO2	Learn the Key RF, PHY, MAC, and air interface changes required to support 5G.
CO3	Understand the Radio technology that enables devices to communicate directly with each other without any additional network infrastructure.
CO4	Evaluate implementation options for 5G.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	-	-	-	2	2
CO3	2	2	-	-	-	-	-	-	-	-	2	2
CO4	2	-	-	-	1	-	-	-	-	-	2	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Overview of 5G Broadband Wireless Communications:** Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G. **5G wireless Propagation Channels**: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling.	**8**
2	**5G Wireless System Architecture**: Basic Radio Accesses Network (RAN) architecture, High level requirements for the 5G Technology, Functional Architecture and flexibility–integration of LTE, LTEA and new air-interface to fulfill 5G requirements, Enhanced multi RAT coordination towards 5G, Physical Architecture and Deployment, Deployment enablers, flexible function placement in 5G deployments.	**9**
3	**Transmission and Design Techniques for 5G:** Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques– orthogonal frequency division multiple accesses (OFDMA), Generalized	**9**

	frequency division multiple accesses (GFDMA).	
4	**Non-orthogonal multiple accesses (NOMA):** Device-to-device (D2D) and machine-to-machine (M2M) type communications–Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications, Millimeter-wave Communications, spectrum regulations, deployment scenarios, beam-forming, physical layer techniques, interference and mobility management, Massive MIMO.	**8**
5	**MAC Layer for 5G:** Overview of Wireless MAC Protocols and its Characteristics, Case Study, Implementation and Analysis of MAC Protocols in Lab View/MATLAB.	**6**

Text Books:

1. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
2. Afif Osseiran, Jose. F. Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks", Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications.
5. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.

Electronics & Communication Engineering			
ECO711	**Low Power VLSI Circuits**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Identify the sources of power consumption in a given VLSI Circuit
CO2	Analyze and estimate dynamic, leakage power components in a DSM VLSI circuit
CO3	Choose SRAMs/ DRAMs for Low power applications
CO4	Design low power arithmetic circuits and systems
CO5	Decide at which level of abstraction it is advantageous to implement low power techniques in a VLSI system design

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	1	2	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	3	-	-	-	-	-	-	-	-
CO4	1	2	-	2	-	-	-	-	-	-	-	-
CO5	1	1	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction:** Sources of Power Dissipation, Static Power Dissipation, Active Power Dissipation, Circuit Techniques for Leakage Power Reduction.	**8**
2	**Adders:** Standard Adder Cells, CMOS Adders Architectures, Low Voltage Low Power Design Techniques, Current Mode Adders.	**8**
3	**Multipliers:** Types Of Multiplier Architectures; Braun, Booth Multipliers and their performance comparison, Low Voltage Low Power Design Techniques.	**10**
4	**Memories:** Sources of power dissipation in SRAMs, Low power SRAM circuit techniques, Sources of power dissipation in DRAMs, Low power DRAM circuit techniques.	**10**
5	**Wires:** Increased delays of wires, new materials for wires and dielectrics, Basic background on testing, Low power and safely operating circuits, Case study–A Low power subsystem design.	**8**

Text Books:

1. Kiat Seng Yeo and Kaushik Roy, Low- Voltage, Low-Power VLSI Subsystemss, Edition 2009, Tata Mc Graw Hill .
2. Soudris D, Piguet C and Goutis C, Designing CMOS Circuits for Low Power, Kluwer Academic Publishers, 2002.
3. Jan Rabaey, Low Power Design Essentials, Springer.

Electronics & Communication Engineering			
ECO712	Biomedical Instrumentation	L	T
		3	0

Course Outcomes: After completion of the course student will be able to:

CO1	UNDERSTAND the origin of bio-potentials, anatomy and their physical significance
CO2	ANALYZE ECG, EEG and EMG signals and respiratory system measurement
CO3	ANALYZE medical imaging systems
CO4	DESIGN Therapeutic and prosthetic devices.
CO5	APPLY Medical application of LASER and safety measures of instruments.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	3	-	-	-	-	-	-	3
CO3	3	-	-	-	3	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	-	-	-	3
CO5	2	-	-	-	3	-	-	-	-	-	-	3

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Basic Medical Instrumentation System**: Static and dynamic characteristics of medical instruments, Bio-signals and characteristics. Problems encountered with measurements from human beings. **Bio-Potential Electrodes and Physiological Transducers:** Electrode potential, Electrode equivalent circuit, Types of Electrodes-Surface Electrodes, Needle Electrodes, Micro Electrodes. Pressure transducers, Transducers for body temperature measurement.	14
2	Electrical Conduction system of the heart, Block diagram Of Electrocardiograph, ECG leads, Einthoven triangle, ECG amplifier, EEG 10-20 lead system, Specifications and Interpretation of ECG, EEG, EMG.	8

3	**Blood flow meters:** Electromagnetic blood flow meter, Ultrasonic Doppler blood flow meter. Blood pressure measurement- Ultrasonic blood pressure monitoring. **Physiological Assist Devices & Therapeutic Equipment:** Pacemakers, External & internal, Defibrillators, External & internal, Hemodialysis machine.	**10**
4	Spirometry, Pnemuotachograph, Ventilators Monitoring Equipment: Arrhythmia Monitor, Foetal Monitor, and Incubator. **Medical Imaging Equipment:** X-ray generation, X-ray tube, X-ray machine, Computed Tomography (CT), Ultrasound Imaging system.	**10**
5	Electric shock hazards, Leakage currents, Test instruments for checking safety parameters of biomedical equipments.	**8**

Text Books:

1. L. A. Geddes and Wiley, Principles of Biomedical Instrumentation L. E. Baker (2nd Ed.)
2. L. Cromwell, Biomedical Instrumentation and Measurements, Prentice Hall.
3. John G. Webster (Ed.), Medical Instrumentation – Application and Design, 3rd Edition, John Wiley & Sons Inc.
4. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata McGraw Hill.
5. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication.
6. Medical Instrumentation Application and Design by J. G. Webster, Wiley Publication.

Electronics & Communication Engineering			
ECO713	**MEMS Technology**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Understanding of MEMS and Microfabrication.
CO2	Understanding of MEMS materials.
CO3	Application of Sensing and Actuation.
CO4	Understanding of Micromachining.
CO5	Understanding of Optical MEMS.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	1	-	-	-	-	-	-	-	-
CO2	-	3	-	1	-	-	-	-	-	-	-	-
CO3	-	3	-	3	-	-	-	-	-	-	-	-
CO4	1	2	-	2	-	-	-	-	-	-	-	-
CO5	-	1	-	-1	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to MEMS and Microfabrication:** History of MEMS Development, Characteristics of MEMS-miniaturization–microelectronics integration-Mass fabrication with precision. Micro fabrication-microelectronics fabrication process-silicon based MEMS processes-new material and fabrication processing-points of consideration for processing.	**14**
2	**Electrical and Mechanical Properties of MEMS Materials:** Conductivity of semiconductors, crystal plane and orientation, stress and stain–definition– relationship between tensile stress and stain-mechanical properties of silicon and thin films, Flexural beam bending analysis under single loading condition- Types of beam- deflection of beam-longitudinal stain under pure bending spring constant, torsional deflection, intrinsic stress, resonance and quality factor.	**8**

3	**Sensing and Actuation:** Electrostatic sensing and actuation-parallel plate capacitor–Application-Inertial, pressure and tactile sensor parallel plate actuator-comb drive. Thermal sensing and Actuations-thermal sensors-Actuators-Applications-Inertial, Flow and Infrared sensors. Piezo resistive sensors- piezo resistive sensor material- stress in flexural cantilever and membrane-Application-Inertial, pressure, flow and tactile sensor. Piezoelectric sensing and actuation- piezoelectric material properties-quartz-PZT-PVDF–ZnO Application-Inertial, Acoustic, tactile, flow-surface elastic waves. Magnetic actuation- Micro magnetic actuation principle- deposition of magnetic materials-Design and fabrication of magnetic coil.	**10**
4	**Bulk and Surface Micromachining:** Anisotropic wet etching, Dry etching of silicon, deep reactive ion etching (DRIE), and Isotropic wet etching, Basic surface micromachining process- structural and sacrificial material, stiction and antistiction methods, Foundry process.	**10**
5	**Polymer and Optical MEMS:** Polymers in MEMS- polymide-SU-8 liquid; crystal polymer (LCP)-PDMS-PMMA-Parylene-Flurocorbon, Application-Acceleration, pressure, flow and tactile sensors. Optical MEMS-passive MEMS, optical components-lenses-mirrors-Actuation for active optical MEMS.	**8**

Text Books:

1) Foundation of MEMS, Chang Liu, Prentice Hall.
2) Microsystem Design, Stephen D. Senturia, Springer.
3) Analysis and Design Principles of MEMS Devices, Minhang Bao, Elsevier.

Electronics & Communication Engineering			
ECO714	**Smart Antenna**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	To Familiarize with smart and adaptive antennas.
CO2	To study about the different adaptive algorithms for the antenna.
CO3	Understanding the concept of direction of arrival and angle of arrival**.**
CO4	To analyze the effect of mutual coupling and to study the space time**.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	-	-	-	3	-	-	-	-	-	-
CO2	3	-	-	-	3	-	3	-	-	-	-	-
CO3	3	2	-	-	2	-	2	-	-	-	-	-
CO4	2	1	-	-	1	3	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**INTRODUCTION:** Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Smart Antenna Configurations: Switched and Fixed Beam Antennas, Adaptive Antenna Approach, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.	**8**
2	**FIXED BEAM SMART ANTENNA SYSTEMS:** Introduction, Conventional Sectorization, Antenna Arrays Fundamentals: Linear Arrays, Array. Weighting, Circular Arrays, Rectangular Planar Arrays, Fixed Side lobe Canceling, Retro directive Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beam formers, Switched Beam Systems, Multiple Fixed Beam System.	**8**
3	**ADAPTIVE ARRAY SYSTEMS:** Uplink Processing: Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beam forming, Fixed Multiple Beams versus Adaptive Beam forming. Downlink Processing: Transmit Diversity Concepts, Downlink Beam forming, Spatial Signature Based Beam forming, and DOA-Based Beam forming.	**9**

4	**ANGLE-OF-ARRIVAL ESTIMATION:** Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate.	**9**
5	**MOBILE STATIONS' SMART ANTENNAS:** Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual Antenna Performance Improvements, Downlink Capacity Gains, Principles of MIMO systems: SISO, SIMO, MISO,MIMO.	**8**

Text Books:

1. Ahmed El Zooghby, 'Smart Antenna Engineering', ARTECH HOUSE, INC, 2005.
2. Frank B. Gross, 'Smart antenna with MATLAB', Second Edition, McGraw-Hill, 2015.

Optical Fibre Lab

List of experiments

1) Demonstration of OTDR.
2) To cut and splice Fibre.
3) To calculate splicing loss.
4) To calculate the loss in Fibre.
5) To calculate bending loss in Fibre.
6) To calculate MFD.
7) To calculate the Numerical Aperture of given Fibre.
8) To study polarization of Fibre.
9) To study Coupling loss in Fibre.
10) To establish a Fibre network.